

## Fifteen Years of Forest Community Management in Niger: from a Technician's Dream to Social Reality

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Accepted: 3 February 2012 / Published online: 22 March 2012  
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**Abstract** Forest management policies in tropical countries have undergone a paradigm shift in the 1980s. International environmental policies have recommended redirecting natural resource management from state control to approaches giving responsibilities to local people. In Niger, forest cooperatives and firewood rural markets characterized the transition in forest policies toward the integration of rural people in forest management. Forest management principles have been progressively adapted to the social and ecological context, since the establishment of the first cooperatives in 1986. Changes in forest policies concerned two fronts: forest management governance and forest management technical instruments. In this paper, the impact of governance and technical instruments on forest management is studied in two types of firewood rural markets found in Niger. Both rural markets have been designed to bring about a governance shift in favour of rural people. In one type of rural market, rigorous technical instruments were added, consisting in a rotational system among several plots to be harvested in the forest. This paper shows that in the implementation of rural markets, the shift is mainly on governance of forest management, and not so much on technical instruments. The general management principles remain based on scientific knowledge and are not enforced by rural people. These principles have been shown to be inappropriate with regard to Sahelian people's representation of space, but because they are scientific, they cannot be questioned. The study suggests that sustainable forest management will be better served by interesting rural people in the rural markets, and thereby

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promoting their appropriation of forest resources, than by defining rigorous technical rules.

**Keywords** Sahel · Firewood · Rural markets · Technical instruments · Devolution of forest management · Forest policies

## Introduction

Fighting the degradation of tropical forests is a major challenge for international environment policies. In the 1980s, the way to tackle this problem underwent a paradigm shift (Becker 2001). Recommendations on natural resource management were redirected from State control to approaches giving responsibilities to local people. In the forest field, this new trend has been recorded in international policies by the publication of the ‘Forest principles’ following the earth summit in 1992 (Wardell and Lund 2006).

In its colonies, the French administration has introduced the European notion of forest as an entity isolated from the farmlands (Foley et al. 2002). In French-speaking West Africa, the 1935 forestry decree provided the basis of forest policies (Becker 2001). This decree stated that ‘all land that is vacant and un-owned belongs to the State’ (Bertrand 1985, p. 26), thus laying down the State appropriation of forests. The forest departments were established during this period on the model of the French paramilitary forest administration. The role of forest civil servants was then to protect forests against rural people (Foley et al. 2002) because their practices were identified as the main cause of forest degradation. The emergent forest science in France and Germany promoted this system of management (Becker 2001). Technical and legal instruments which were defined based on European experiments were introduced in West Africa as well as in several European colonies (Peluso 1992). As it was decreed that only the State was entitled to manage forests, the rights of rural people were reduced to the use of non-commercially valuable forest resources (Ribot 2001).

Various arguments were advanced to explain the necessity for a change in these forest management paradigms in tropical countries, the most important of which related to the denial of rural people’s access to forest resources (Larson 2005). Beyond ethical considerations, several studies evidenced the capacity of local people to sustainably manage forests which were inhabited by them for years (Porter-Bolland et al. 2012). The lack of financial means in forest management was another argument to promote forest decentralization. These new trends in forest management approaches led to various experiments. In West Africa, associative structures were set up to organize forest management by rural people. These included the rural markets of firewood (*‘marchés ruraux de bois énergie’*) in Niger (Montagne 1997) and in Mali (Gautier et al. 2011), the Community Forests in Cameroun (Cuny et al. 2006), and the Forest Management Group (*‘Groupements de gestion forestière’*) in Burkina Faso (Sawadogo 2006).

In the Sahel, firewood supply for urban households was a major concern associated with forest degradation. Forest harvesting for firewood was mentioned as

being one of the main causes of forest degradation and fuelwood shortage as the most worrisome consequence of that degradation (Ribot 1999). Although Niger did not face fuelwood shortage episodes when supplying its cities, the World Bank initiated a project common to the fuelwood field and forestry in the country in 1978. A survey carried out within this project showed that the fuelwood harvested in natural woodlands provided all the cooking fuel used by urban families (Foley et al. 2002). The first experiments in community forestry were developed by the USAID-funded Forestry Land Use and Planning Project (FLUP) which introduced the forest cooperatives in 1986. Edict number 92-037 confirmed the shift of responsibility of forest management from the State to rural people, by introducing the concept of rural markets of firewood. The household energy project (HEP) initiated this policy reform.

Edict number 92-037 defines the rural markets (RM) as ‘places where organizations are set up for commercial exploitation of firewood outside big towns’. Although RMs are organized around wood trade, the concept is much broader than sites for commercial exchange. An RM designates a delimited forest area where the management responsibility has been assigned to a local community. The community is organized within an association called ‘Local Structure of Management’ or LSM (Foley et al. 1997). LSM members have exclusive rights on the sale of firewood harvested in the forest area of their RM. They have to follow rules established by forest technicians in a forest management plan (Montagne 1997).

Forest management plans and technical rules differ depending on the RM type. Two RM types were defined by Edict number 92-037 as ‘directed’ and ‘controlled’ (Foley et al. 1997). In directed RMs, the forest area is delimited and an annual harvesting quota is set but no formal management plan is agreed upon. In controlled RMs, the forest area is delimited and its harvesting is organized by a detailed management plan. This plan specifies the division of the forest area into plots, the rotational system (one plot corresponds to an annual wood-harvested area), the annual harvesting quota, and the forest management measures.

In this paper, the strategies used by the HEP to create favourable conditions for the sustainable management of forests were analysed by studying the instruments implemented in rural markets. The strategies used by the HEP reveal the premise that natural resources would be better managed if rural people appropriate the forests and if they make profit from forest management (Mahamane and Montagne 1997). Another conviction was that forest harvesting requires control by rigorous technical instruments (Peltier et al. 1995; Djibo et al. 1997). Whereas such policy reforms broke away from the colonial heritage, the technical instruments remained influenced by European approaches based on inventories, rotational systems and quotas. However, these instruments have progressively changed, in particular with regard to harvested species regeneration and rural people’s practices in Niger (Peltier et al. 1994).

The objective of this study is to analyse the effects of changes in forest management in Niger, i.e. forest management governance and forest management technical instruments, on rural people’s practices, on their livelihoods and on the forest ecosystems. The paper explores (1) how the methods in forest management

have been elaborated since the first experiments of forest management devolution and (2) the way these methods have been implemented in two types of rural markets of firewood and the practices related to forest management.

## Research Method

The research was carried out in three main steps. Firstly, a literature review and a survey of the evolution of forest management policies since 1988 were conducted. Secondly, a survey and observations at the village level were conducted to analyse the implementation of the new instruments in both types of RMs and the socio-economical changes they involved. Thirdly, the ecological changes brought about by the RMs in both sites were studied through ecological inventories.

### Forest Management Policy Changes: Project Literature Review and Survey at National Level

Several reports were written in the context of the IDA/FAC/CCCE forestry project which set up a forest cooperative in 1988 (Faïra cooperative forest) and in the context of the HEP which set up RMs from 1989 to 2003. These reports were studied to understand the vision of forest management in these projects and to analyse the technical instruments discussed by the forest experts to achieve their objectives. Project reports were also used to analyse how the technical rules were precisely defined in the studied RMs. At the regional and national scales, nine officers of forest departments were interviewed in 2009 to understand their conception of forest management and the way they implemented the rules in RMs.

### Local Practices and Socio-Economical Changes: Surveys and Observations at Village Level

At local level, the analysis was based on surveys conducted in a directed RM (Ninpelima case study) and in two controlled RMs (Tientergou case study). These RMs were chosen because they were among the first RMs created in Niger in 1993. Their accessibility by firewood traders is quite similar because both are located near all-weather roads and at a roughly equivalent distance from Niamey (70 km). The comparison of these two cases allows test whether the main changes in local forest management are more linked to the new rights given to local people in the edict, or to strict regulations on forest uses.

The surveys were carried out in 2007 in Tientergou and in 2009 in Ninpelima (Table 1). About 30 % and 22 % of the total population were interviewed in Ninpelima and Tientergou RMs, respectively. Semi-structured individual interviews were conducted in both case studies. Interview guides were developed to address three main topics: (1) the current functioning of the RM including the rules implemented by the LSM, its organization and woodcutters' practices; (2) the socio-economical changes induced by the RM set up including the villagers' perception about these changes, and (3) the ecological changes as perceived by the villagers.

**Table 1** Interview samples in Ñinpelima and Tientiergou

Location	Fulani people	Fulani people interviewed		Gourmantche people	Gourmantche people interviewed	
		Men/ women	Sampling rate (%)		Men/ women	Sampling rate
<b>Ñinpelima area</b>						
Ñinpelima Rural Market	47	6/8	29.8	322	48/47	29.5 %
Neighbouring Rural Market		1/1			10/2	
<b>Tientiergou area</b>						
Tientiergou Rural Market	210	36/10	21.9			
Bango Rural Market	85	14/6	23.5			

Specific interviews were performed with LSM representatives on the manner of implementation of rules in the RMs and on changes in RMs functioning since 1993. In Ñinpelima, the survey was run in the five villages of the RM and in neighbouring villages to understand better their relations with Ñinpelima RM and investigate the issue of forest boundaries. In Tientiergou, the survey was run in two neighbouring RMs.

The interviews were completed by observations on woodcutters' practices, the type of wood sold in RMs, and the trees and wood in the landscape. Going over ledgers kept by LSM managers also provided useful data on wood sales, expenditures and LSM tax revenues.

### Ecological Changes: Tree Inventories

The ecological changes were assessed through the study of changes in the vegetation structure due to firewood harvesting. In Tientiergou, the effects of wood harvesting were assessed by comparing the results of 1990 and 2007 inventories. Both inventories were made on 100 plots of  $100 \text{ m}^2$  ( $10 \times 10 \text{ m}$ ). In the 2007 inventory, systematic sampling was conducted on three tracks running from the road, one kilometre distance from one another. On each track, plots were 100 m away from one another. In each plot, the number of stems higher than 4 m, and the diameter at 1.30 m high (dbh) of stems with a diameter larger than 3 cm were measured and the species were recorded. Only harvested species were inventoried. The inventory methods were slightly different from those used in 1990, when only stems with diameter greater than 4 cm on the ground were measured. A diameter of 4 cm on the ground is assumed to correspond to a diameter of 3 cm at 1.30 m, and the two inventories are assumed to be comparable.

In Ñinpelima, given that no previous inventory data were available, the effects of wood harvesting on vegetation were assessed by a comparison between vegetation inventories in harvested and non-harvested plots (11 and 7 plots respectively). Plots

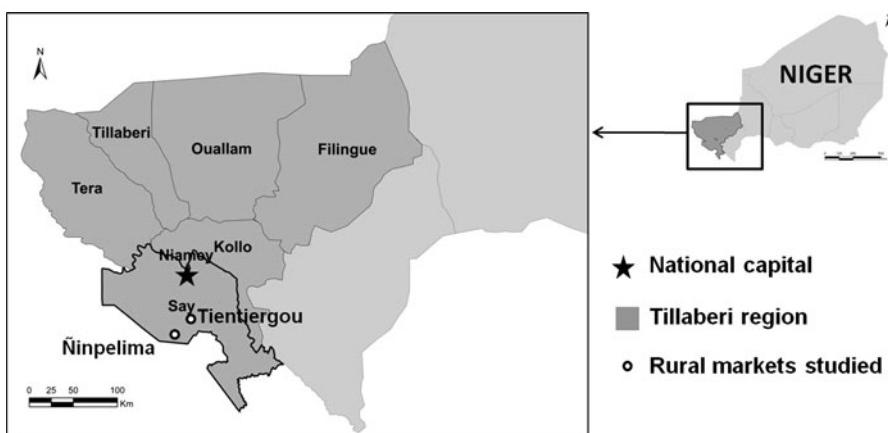
of  $100 \text{ m}^2$  ( $10 \times 10 \text{ m}$ ) were selected in woodland areas based on their land use. When possible, plots were chosen in similar ecological formations. For each stem, the species, the height and diameter at 20 cm high were noted. All ligneous species were inventoried.

## The Study Location

Ñinpelima and Tientiergou are located in the southwest of Niger, Say Department, Tillaberi Region (Fig. 1).

Both sites are subjected to similar climatic and ecological conditions. The climate is Sudano-Sahelian with a long dry season (October to May) and a short rainy season (June to September). The annual rainfall is about 600 mm. The landscape alternates plateaus with superficial lateritic soil, valleys with deep ferruginous soil and slopes between plateaus and valleys with sandy soil (D'Herbès et al. 1997).

Ñinpelima is a directed RM, composed of five villages. It is surrounded by six other directed RMs. Ethnic groups are Fulani and Gourmantche. The Gourmantche customary chief is in charge of collecting State taxes and acts as an arbiter in farmland access issues. The Fulanis have their own traditional chief who is in charge of resolving conflicts between farmers and breeders. From a legal standpoint, harvesting commercial wood in woodlands required a permit from the Forest Department before the RM was set up (République du Niger 1974). Since the RM has been set, only the woodcutters from the villages of the RM are allowed to harvest commercial firewood within the boundaries of the delimited forest area. Any villager who has use rights in the area is allowed to harvest. Woodcutters have to comply with an annual quota of 2650 steres of wood which can be harvested anywhere in the RM forest area and have to be sold at a specific sales point. The price is negotiated between the LSM manager and the traders from Niamey. The



**Fig. 1** Location of the rural markets of Ñinpelima and Tientiergou

latter have to pay a tax of 300 FCFA<sup>1</sup>/stere<sup>2</sup> to the LSM in exchange for a receipt as proof of payment. Tax revenues are distributed as follows: 30 % to the LSM, 20 % to the rural council and 50 % to the State treasury (Montagne 1997).

Twelve controlled RMs were set up in Tientergou forest massif, each covering one village. The ethnic group in this area is mainly Fulani, composed of noblemen called Fulbe and their former slaves called Rimaïbe. The 12 villages are under the authority of several Fulbe customary chiefs. The land of each village has been identified by the first settlers. The customary chiefs have maintained their authority on land clearing for agricultural purpose. The woodlands are within the authority of a customary chief but they can be collectively used by the villagers (Djibo et al. 1997).

The rules on firewood harvesting are similar to those in Nînpelima, but each RM forest area has been divided into six plots, each harvested for 1 year in rotation. The list of species allowed to be harvested and the minimum diameter cutting are reported in the management plan: 6 cm for *Combretum micranthum* and *Guiera senegalensis* and 8 cm for *Combretum glutinosum* and *Combretum nigricans* (Peltier et al. 1995). The tax amount is 315 FCFA/stere and it is distributed 50 % to the LSM, 40 % to the rural council and 10 % to the State treasury (Montagne 1997).

## Results

### Progressive Change of Forest Management Paradigms in Nigerien Policies

The study of the IDA/FAC/CCE and the household energy projects show how the new paradigms emerging in international policies have been progressively applied to the forest policies of Niger, and specifically in the firewood sector. Forest cooperatives and RMs were designed to address the issue of sustainable forest management along with the firewood supply for urban households. The RMs were designed based on the experience of forest cooperatives.

### *Switch from Plantations to Natural Woodlands for Firewood Supply*

After Niger Independence, forest programs focused on tree plantations. Following the 1974 drought, donors increased funding programs on forest management. In 1984, another drought revealed the failure of forest plantations. The forestry land use project (FLUP) was created to explore the production capacities of natural forests, through tree inventories in woodlands (Foley et al. 1997). FLUP investigations on natural forest management were carried out in the Guesselbodi classified forest in 1986 where a forest cooperative had been set up. This involvement in natural forest management has been pursued in RMs since 1992.

<sup>1</sup> 1 FCFA = 0.15245 € (exchange rate in 2011).

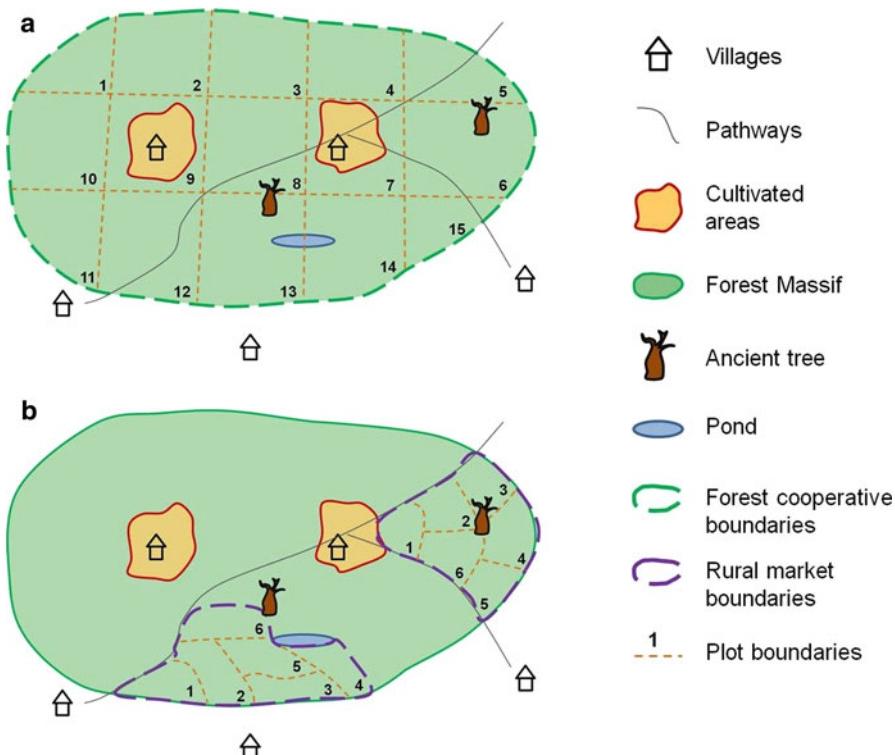
<sup>2</sup> 1 stere = 1 m<sup>3</sup> of stacked firewood.

## Involving Local People in Forest Management

The involvement of local people in forest management began in Niger with the forest cooperative of Guesselbodi. Forests to be managed by cooperatives were designed according to biophysical criteria (forest massif). They stretched over a large area and included many villages (Fig. 2). For example, Faïra forest, where a cooperative was created in 1988, covered seven villages with about 8000 inhabitants and had a surface area of 8020 ha (Projet IDA/FAC/CCCE 1988). The high number of villages grouped within a cooperative reduced social cohesion and was a source of conflicts between villages. The distance between villages and plots to be harvested undermined the woodcutters' desire to harvest wood and increased the cost of plot supervision (Foley et al. 1997). This experience in cooperatives led forest experts to suggest restricting the RM forest area to 1800 ha. They estimated that 1800 ha was the surface area upon which a village of 250 people could manage the forest sustainably (Peltier et al. 1994).

### Changing the Way to Establish Management Plans

The method of establishing management plans has changed since the first cooperatives were set up. The two main technical rules discussed by forest



**Fig. 2** Representation of forest area and plot boundaries in cooperatives (*top*) and firewood rural markets (*bottom*)

technicians have been the delimitation of the forest area boundaries and the rotational system. Forest technicians identified the forest area boundaries of the cooperatives based on the physical limits of the forest massif (Fig. 2). These massifs were geometrically divided into plots (Peltier et al. 1994). The assessment of the cooperatives made by the HEP showed that, as villagers had not been involved in the identification of the boundaries of the forest area and the plots, they did not recognize them. In order to overcome these problems in RMs, forest technicians chose to define the limits of the forest areas where the management responsibility was assigned to the LSM in collaboration with the villagers and based on boundaries recognized by the villagers such as a track, a river or a tree (Fig. 2) (Peltier et al. 1995).

The way of defining the rotational system has changed several times since the first management plans were established in forest cooperatives. Discussions are still underway at time of writing to define what the best number of plots and the best rotation are to ensure sustainable firewood harvesting. In the forest management plan of Faiira cooperative, forest technicians identified 15 plots of 530 ha with a 15-year rotation. Forest experts estimated this turnover based on their experience because no study was available on the annual growth of harvested species. ‘In Guesselbodi [the rotation] was on 10 years. We think this latter rotation is too short to have enough stems with a marketable size and to protect the other interest in the field. For the first exploitation unit, we fixed a 15-year rotation. The research will show what the most profitable rotation is’ (Projet IDA/FAC/CCCE 1988, Section II, p. 12).

The experience of the cooperatives highlighted the difficulty of defining the boundaries of the plots and having these respected by the woodcutters, even more so when the plot number is high. Moreover, forest experts working on the design of management plans for RMs argued that, contrary to the clear cutting method, the selective cutting method traditionally used by the woodcutters allows a plot to be harvested more frequently (Peltier et al. 1994, 1995). An assessment in experimental conditions in the south west of Niger concluded that 6 years were enough to regenerate a forest selectively harvested following a minimum cutting diameter from 6 to 8 cm (Ichaou 2000), (Fig. 2). During the same period, another expert of the HEP claimed that designing management plans with plots was highly expensive and time consuming. He suggested testing a management plan with only one plot where harvesting would be controlled by a wood harvest quota and a strict identification of harvestable stems. This suggestion was not followed. But the issue of financial cost to establish management plans with plots was finally addressed in the directed RM, designed as a strategy to ‘allow a quicker and broader dissemination of the rural market concept’ (Foley et al. 1997, p. 92). However, the principle of directed RM was deleted in the new forest law of 2004 (République du Niger 2004). Forest officers argued that forest management need a rotational system to be sustainable.

In 2009, the division into plots was challenged again. To convert former directed RMs into controlled RMs, forest experts suggested a management plan with only one plot from which woodcutters could harvest wood moving forward in a single direction. That rule was rejected by the Forest Department and the new management plans have been constituted with three plots and a 9-year rotation where each plot is harvested for 3 years.

## Forest Management Practices in Nînpelima and Tientiergou Rural Markets

### *Delimitation of the Rural Market Forest Areas*

When RMs were created, the way to define the RM forest areas differed between Tientiergou and Nînpelima due to the local history of land and land access organization. In Tientiergou, the customary chiefs defined the limits of the RM forest areas according to the villages' territories. In Nînpelima, because the area covered by the customary chief was very large (36,000 ha), several RMs were organized. LSM representatives reported that the choice of villages to be included in each RM was decided by forest officers. After this stage where the general RM forest area was defined in both sites, the precise boundaries of this area were identified by LSM representatives and forest officers in consultation with LSMs of neighbouring RMs. In Tientiergou, the division into plots was designed to obtain a homogeneous distribution of harvestable wood on six plots of 300 ha each (Djibo et al. 1997).

Survey in the present study show that in practice most of the woodcutters from Nînpelima can locate their RM forest area but do not know exactly where the boundaries are set. Moreover, they recognize the fact that they are also harvesting in the forest area of neighbouring RMs, whereas woodcutters from the neighbouring RMs are also harvesting in the forest area of Nînpelima RM. An LSM member reported that 'At the beginning, we did not have this problem, there was wood everywhere and we did not feel the delimitation because we were able to stay in our village'. Now, it is obvious for Nînpelima LSM that a woodcutter from a neighbouring RM is allowed to harvest in their RM forest area if the wood is exhausted in the forest area of his own RM. They said 'In Mossipaga [a neighbouring RM] forest is exhausted. They are forced to come in our forest'. However, LSM members consider that woodcutters from Niamey are not allowed to harvest firewood in their RM forest area.

The woodcutters from Tientiergou say that forest area boundaries are respected. However, in one RM stems with diameters larger than those present on its grounds were observed at the sales point. The fact that woodcutters do not admit they cut outside their RM forest area suggests that they consider this practice as forbidden. The division into plots is not respected, and woodcutters exploit wood in the whole forest area without any rotation.

### *Quality and Quantity of Harvested Wood*

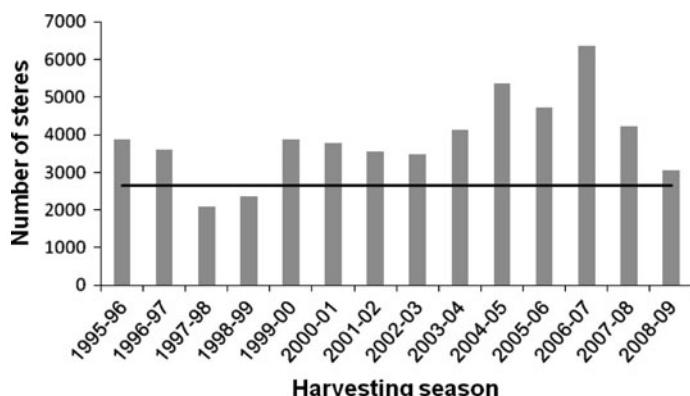
When the harvesting rules were designed in RMs, the type of harvestable wood was expressly defined by the management plan of Tientiergou, which was not the case in Nînpelima. To define the quantity of wood to harvest (quota), forest experts combined wood inventories and Landsat satellite images. Three classes of forest cover density were identified. Various studies on Sahelian forest productivity were used to define wood productivity in each class (Peltier et al. 1994). In Tientiergou, the annual wood productivity was estimated at 1.2 m<sup>3</sup>/ha (only for harvestable wood), i.e. 360 m<sup>3</sup>/year in one plot of 300 ha (Bellefontaine et al. 1997). Data on the definition of quota in Nînpelima was not available.

With regard to the quality of harvested wood, all respondents in the survey (forest civil servants, woodcutters, LSM representatives and traders in Nînpelima) agree that in directed RMs, woodcutters have to harvest only dead trees, while they are allowed to harvest live trees in controlled RMs. Although it is not mentioned in regulatory documents, the association between directed RM and dead wood harvesting has been set as a rule and acknowledged by all. However, the surveys and observations show that woodcutters are exploiting live trees in both RMs.

Woodcutters do not make any distinction between protected and non-protected species. However, in Nînpelima, woodcutters avoid harvesting species which produce edible fruits (*Vitellaria paradoxa*, *Parkia biglobosa*, *Tamarindus indica*, *Ficus* sp.). The wood observed at the sales point reveal that these species are harvested in small quantities. Woodcutters harvest the species in answer to the traders' demand. Consumers prefer wood from *Combretum nigricans*. However, this species is in short supply, which led woodcutters to harvest other species, in particular *Combretum micranthum*, *Guiera senegalensis*, *Combretum glutinosum*, *Anogeissus leiocarpus* and *Piliostigma reticulatum*.

The minimum diameter of harvested wood was assessed by interviews and measures on wood steres. In Nînpelima, a minimum diameter of three centimetres is revealed by both information sources. In Tientiergou, woodcutters declare a minimum diameter of 6 cm but observations reveal smaller stems. In both RMs, woodcutters' sale strategy consists in mixing small with medium wood.

With regard to the quantity of harvested wood, the collection of data in the LSM ledger show that the quota of 2650 steres has been exceeded in Nînpelima almost every year since 1995 (Fig. 3). LSM representatives said: 'At the beginning, we received fines when we exceeded the quota. But quickly, we have agreed that dead trees would be eaten by termites if they were not harvested. Therefore, we stopped the quota in agreement with the Forest Department'. Although this decision is not ratified by a decree or a circular, the agreement by civil servants can be seen in the LSM ledger. Whereas the non-compliance of quota appears clearly in the monitoring, the ledger is stamped and validated by the forest department.



**Fig. 3** Quota (black line) and number of harvested steres per year in Nînpelima rural market. Source: LSM Ledger

**Table 2** Distribution of stems by diameter class and species in Tientiergou forest on 1 ha (100 plots of 100 m<sup>2</sup>)

Species	Numer of stems 3 < d<6 cm	Numer of stems 6 < d<10 cm	Numer of stems d > 10	Total numer of stems d > 3 cm	
	2007	2007	2007	2007	1990
Date of inventories	2007	2007	2007	2007	1990
<i>Guiera senegalensis</i>	113	36	1	150	
<i>Combretum micranthum</i>	350	136	5	491	
<i>Combretum glutinosum</i>	5	8	7	20	
<i>Combretum nigricans</i>	12	27	5	44	
Total for the four species	480	207	18	705	920
Percent of stems with d > 3 cm	~68 %	~29 %	~2 %	100 %	
Number of dead trees	1	8		9	120

d diameter at 1.30 m high

The decrease observed since 2007 is explained by the failure of the LSM to record scrupulously the wood sold in the RM. According to woodcutters and forest officers, wood leaks—the sale of wood outside sales points—was a common practice in 2008, which was practically abandoned because several woodcutters received fines for this practice.

### Ecological Changes Observed in Nînpelima and Tientiergou

Ecological changes were assessed through two kinds of data: inventories and villagers interviews. Table 2 shows the results of inventories carried out in Tientiergou forest in 1990 (Peltier et al. 1994) and in 2007. In spite of the differences in methodologies of the inventories in Tientiergou, it is clear that the diameter of stems decreased since the RM was created.

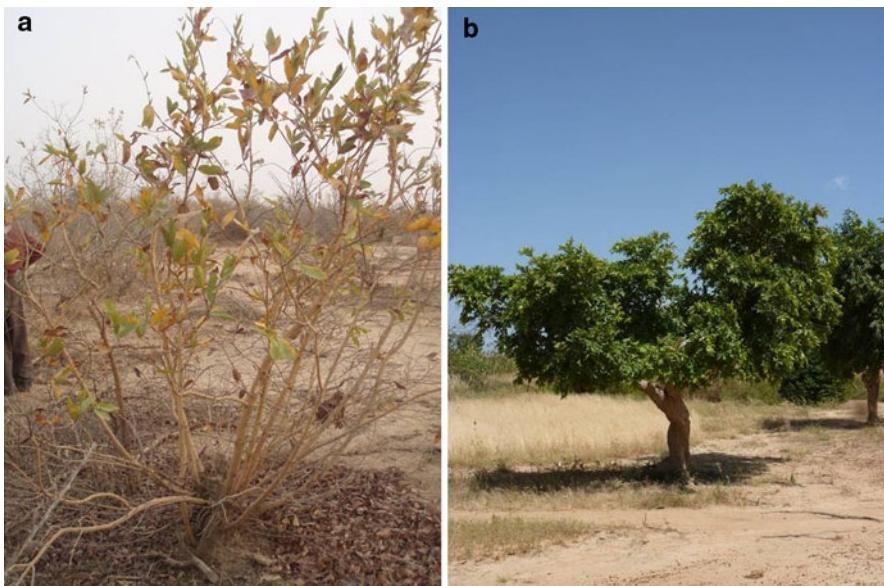
Table 3 shows the results of inventories carried out in Nînpelima forest.

For all the species, stems diameters are smaller in harvested plots. Among all species, *Combretum nigricans* is the most harvested species. The difference in stem distribution

**Table 3** Distribution of stems by diameter class and species in Nînpelima forest on plots of 100 m<sup>2</sup> (average) in 2009

Species	Numer of stems d < 2 cm		Numer of stems 2 < d<4 cm		Numer of stems 4 < d<6 cm		Numer of stems d > 6 cm		Total numer of stems	
	HP	NHP	HP	NHP	HP	NHP	HP	NHP	HP	NHP
<i>Guiera senegalensis</i>	176	136	11	9	0	0	0	0	187	145
<i>Combretum micranthum</i>	54	57	7	24	2	6	0	0	63	87
<i>Combretum nigricans</i>	199	77	42	24	4	10	0	1	245	112
All species	493	314	62	63	6	18	1	2	562	397
Percent of total stems	88 %	79 %	11 %	16 %	1 %	5 %	0 %	0 %	100 %	100 %

d diameter, HP harvested plots, NHP non-harvested plots



**Fig. 4** *Combretum nigricans* from which firewood harvesting has taken place (left) and never harvested (right) in Ninpelima

might be explained by two factors. Stems that had a large diameter were harvested, and *Combretum nigricans* produces a high number of stool shoot after harvesting. These two factors explain why *Combretum nigricans*, as well as all the other species, have a total number of stems larger in harvested plots than in non-harvested plots (Fig. 4).

From the point of view of woodcutters, the quantity of wood for harvesting and the diameters of harvested wood are decreasing. In Ninpelima, many woodcutters worry about decreasing wood availability. *Bush is exhausted* is a frequent remark of villagers. Beyond the issue of firewood, the villagers also feel the consequences of ecological changes in other forest uses. Fulani people and some Gourmantche people underline the decrease of the woody species that are used to provide feed for cattle. All Fulani people want tree harvesting to stop. Gourmantche women also point out the decrease of gum produced by *Combretum nigricans*.

In both study sites, ecological inventories and surveys show that wood harvesting modify the forest structure. However, inventories show that the forest regeneration is maintained. Harvested trees regenerate including species harvested intensively such as *Combretum nigricans*. Beyond the ecological inventories, tree regeneration may also be deduced from woodcutters' practices. Their declarations and our observations in harvested areas show that they have been harvesting the same trees or the same areas several times since 1993.

#### Socio-economical Changes in Ninpelima and Tientiergou

The main socio-economical changes observed in Ninpelima and Tientiergou are linked to the increase of woodcutting activity by the villagers and the income it

provides. In Tientiergou, before the establishment of the RMs, Rimaïbe men used to sell wood along the road to urban traders. Woodcutting was seen as a caste profession and thus no Fulbe was involved in it. With the establishment of RMs, income from wood increased for Rimaïbe people. Accordingly, the negative image of the woodcutting profession disappeared. In Nînpelima, before the establishment of the RM, Gourmantche men worked with wood traders' workers. Since the establishment of the RM, woodcutters are independent. From 1993 to 2000, the number of woodcutters increased from 13 to 45. Since 2007, a few Gourmantche women have also engaged in this activity. Further, there were no woodcutters among Fulanis in Nînpelima in 2009.

On both sites, RMs provide incomes in two ways. Part of the taxes collected from wood transport is allocated to the LSM and wood provides an important source of income for woodcutters. The transport taxes provide cash revenues for the LSM, which finance community investments. In Nînpelima, these revenues per harvesting season range from 198,700 FCFA (1997–1998) to 481,000 FCFA (2004–2005). In Tientiergou, these revenues range from 299,300 FCFA (1992) to 748,200 FCFA (1995). In both villages, the money is used to build schools, mosques and wells, and to run vaccination campaigns. In Nînpelima, villagers decided to finance a community cereal stock in order to provide cereals at lower price than those of the market in the interval between harvests.

The most important change felt by the woodcutters on both sites is the improvement of their livelihoods. According to Nînpelimas woodcutters, the price of firewood increased from 400–600 FCFA/stere in 1989 to 1200–2000 FCFA/stere since the RM was created. Since the establishment of the RM, price has been negotiated between the traders from Niamey and the LSM manager whereas it had been fixed by traders in the past. Moreover, since the establishment of RMs, all incomes go to the villagers because no woodcutters from Niamey come to harvest in their RM forest area. In Tientiergou, woodcutters earn on average 80,000 FCFA/year and up to 300,000 FCFA/year. In Nînpelima, woodcutters earn up to 400,000 FCFA/year. In Nînpelima, the woodcutters mention marriage as the first use of their income from wood. Wood income is used by men to finance their own marriages (dowries for their wives' families can reach up to 400,000 FCFA) or to contribute to the marriages of friends or family members (with a minimum contribution of 5000 FCFA). The woodcutters mention the purchase of cereals as the second use of wood income. Before the establishment of the RM, they had to sell sheep or cattle when the harvests were not sufficient to cover their families' needs for the whole year. Since the RM has been established, whenever the harvests are not sufficient, they sell wood. The woodcutters cited the purchase of livestock, bicycles or motorbikes as the last uses of wood income. Moreover, in both villages, since the creation of RMs, various new economic activities have been developed (store opening, motorbike sale, cycle repair). These activities benefit the men in both RMs and particularly Gourmantche men in Nînpelima. In Tientiergou, 43 % of the women think their income has not increased. In Nînpelima, 84 % of Gourmantche men and 54 % of women notice livelihoods improvements whereas all Fulbe people state negative consequences from the creation of RMs.

The creation of RMs has resulted in the improvement of villagers' livelihoods. However, woodcutters are worried about the decrease in their harvesting activity, and people who do not benefit from wood incomes complain about forest degradation. Some Gourmantche men diversify their activities and sources of income to face the depletion of wood. Money from wood selling is invested in livestock and in orchards to produce fruit. Quoting a recently converted fruit farmer: 'Now that there is no wood, I garden. [...] It is within that [woodcutting] that I could construct my well and plant my garden'. Aslo, a young Gourmantche cattle breeder commented: 'The bush is nearly exhausted and so we bought livestock [...] with the money earned in firewood'.

## Discussion

The evolution of forest management legal instruments in Niger reveals a real breakaway from the colonial heritage but also some persistent dogmas in forest management. Whereas forest technicians aimed at adapting their propositions to social and ecological realities—by changing the way of defining forest area boundaries or implementing a rotational system—, the theoretical basis of forest management seems difficult to question.

This is well illustrated by the changes in the rotational system. The plot number, plot boundaries definition and rotation have been adapted several times as their implementation was tested. However the technical rules have never been applied at the time of this study. Directed and controlled RMs operate in the same way in spite of their different management plans, but the rotational system principle cannot be discussed, even though it is not applied. The removal of the directed RM principle in the 2004 forest law highlights this stance. As Ribot showed in other Sahelian countries (Ribot 2001), the Forest Department resorts to the fear of deforestation to justify the necessity of such scientific principles. However, the trial and error in the definition of such rules show that the scientific basis is not really established. Little is known about the regeneration dynamics of Sahelian harvested species (Bellefontaine 1997). The few studies carried out on wood productivity in Niger are based on one cutting cycle only (Ichaou 2000). Although the present study does not allow precise conclusions to be drawn on wood productivity, it may be assumed that forests are regenerating even after several cutting cycles. The vegetative propagation of harvested species gives them a high regeneration capacity (Bellefontaine 1997).

The smaller diameters of harvested trees could raise concerns about the sustainability of firewood production at local level but the demand adjusts to the supply because firewood is a staple fuel product for urban populations. Considering forest regeneration and adaptation to the firewood demand, it is difficult to estimate the ecological sustainability of the current practices of woodcutters in RMs. In the light of current scientific knowledge, the commitment to the rotational system principle is thus more linked to fear and technical beliefs than to empirical demonstration of its necessity for sustainable management. Some forest experts argue that, given this lack of knowledge, such rules have to be seen as 'watchdogs' to prevent an overexploitation by rural woodcutters (Bellefontaine et al. 1997). This

stance raises doubts about the recognition of rural people capacity to manage forest resources sustainably. This is in line with the analysis of several authors who showed that forest decentralization has transferred to rural people the right to apply and control forest management rules but not the right to define them (Agrawal and Gibson 1999; Ribot 2001; Larson 2005). In the absence of empirical demonstration, there is no evidence in Niger that technical beliefs are better than local practices, as it was argued in other countries (Larson and Ribot 2007).

The issue of the enforcement of forest area boundaries by woodcutters in RM highlights conflicts in the conception of natural resources appropriation between forest experts and rural people. The need for forest appropriation by rural people to ensure sustainable management of forest resources is an important argument in favour of decentralization in Niger (Montagne and Bertrand 2006). In a Western European perspective, the acquisition of property rights on any resource needs identifying precise boundaries of these resources in a specific space. The way to conform forest area boundaries to social realities is to adjust the forest area size and the indicators of boundaries taking into account the experience of forest cooperatives. The current study reveals that RM boundaries are not a constraint for woodcutters despite these adaptations. Beyond the choices of adapting their harvesting area to resource availability, these practices may be linked to the specific spatial logic of the villagers. As in Mali (Gautier et al. 2011), the limits are usually not perceived as precise boundaries. Spatial organization is determined by one place and the control of space is organized from this place (Le Roy 1998). This topocentric logic differs from a geometric representation because rights are determined by the centre and not by the boundaries. Thus, although boundaries were identified with the villagers and based on natural boundaries they recognized, geometrical boundaries were not consistent with their representation of space.

Although rural people do not follow the boundaries of the RM forest areas, they appropriate forest resources. The changes in the way they appropriate their resources is linked to their interest in the RM setup. The main interest for Gourmantche men in Niinpelima and Rimaïbe in Tientiergou is the acquisition of exclusive rights on commercial harvesting of fuelwood. Their new status vis-à-vis urban traders allows them to increase their incomes and reduce their vulnerability, notably to cope with climate hazards. They adapted exclusion rights to the local context: their rules are neither homogeneous nor constant with respect to the various people from outside the RMs. The exclusion of urban traders from wood harvesting is a constant rule but the exclusion of people from neighbouring RMs changed since the RMs were created. Such changes in the local rules and in the way to take advantage of the legal rules have also been described in Malian RMs (Gautier et al. 2011). LSMs adapted the rules on forest management according to the ecological (state of wood resource) and social (social and familial links, fuelwood demand) context but with a concern to maintain the income from firewood production.

This organization of forest management by rural people focused on fuelwood production also shows that some habits remain constant in spite of real changes. Whereas those who benefit from wood harvesting are no longer urban traders but rural people, forest management by LSMs is still being conceived around wood commercial uses. This becomes a problem because effective forest management

does not depend solely on wood use. The issue of focusing on a single use was also criticized in Burkina Faso in the case of ‘forest management groups’ on the grounds that they do not promote livelihood diversity (Sawadogo 2006). Moreover, some minorities, e.g. women or Fulani in Niinpelima, do not directly benefit from the woodcutting activity. As Leach et al. (1999) argued, contrary to the premise of the Community Based Natural Resource Management, the ‘community’ of rural people is neither homogeneous nor static. Moreover, the strategy to cope with several hazards in Sahelian areas is based on the diversification of forest uses, including at household level (Raynaut 2001; Mortimore 2010). Fuelwood production has an ambiguous role in diversification. Although it limits some forest uses (gum production, tree fodder), it also promotes investments in diversification of activities (tree planting, livestock).

## Conclusion and Policy Implications

Since the principle of devolution of forest management to rural people has been integrated in legal instruments, the forest management technical instruments have been changing. Although some dogmas persist, there is a co-evolution between the technical rules suggested by forest experts and rural people’s practices. There is still a long way to achieve the goal of sustainable forest management but the improvement of rural livelihoods and the reappropriation of the forest by rural stakeholders are a first step in this direction. The present study suggests that sustainable forest management will be better served by interesting rural people in the RMs—and thereby promoting their appropriation of forest resources—than by defining rigorous technical rules. In such a context, if the capacity of rural people to manage the forest was fully recognized, legal instruments which could be adapted by rural people themselves as suggested by Ribot (2002) would be imagined. Rural people are more likely to respect rules they helped to define (Larson 2005). In a context where the forest department has little means, defining technical rules that are easier to apply and control would be more efficient.

Despite these economic aspects, Sahelian ecosystems are affected by recurrent droughts that may rapidly affect forest resources. Forest cover may expand or decline partly because of climate hazards. Such unpredictable changes would be easier to face with flexible rules. If rural people had more latitude to implement the rules, they would be able to adapt these rules rapidly when facing sudden changes.

Forest management should also include the diversity of uses in its methods. Firstly, recognizing multiple forest uses would promote internal regulations among users by legitimizing each use. Secondly, when social-ecological systems have to face multiple hazards, the resilience increases if the range of options is expanded. Including more flexibility and more diversity in local forest management would thus increase resilience of Sahelian social-ecological systems.

**Acknowledgments** We thank Laurène Feintrenie and Steve Harrison for helpful comments on our first manuscript and Marie-Cécile Maraval for English reviewing. We also thank the two anonymous reviewers for their thoughtful comments and suggestions. This work was supported by the ‘Gesforcom’ (Comunal and community forest management) project funded by the European Union and by a scholarship from CIRAD (French Agricultural Research Centre for International Development).

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